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# West Europe Report

SCIENCE AND TECHNOLOGY

FRG INFORMATION TECHNOLOGY: 1984 ANNUAL REPORT

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28 March 1986

## WEST EUROPE REPORT SCIENCE AND TECHNOLOGY

### FRG INFORMATION TECHNOLOGY: 1984 ANNUAL REPORT

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1984 [RESEARCH AND TECHNOLOGY FOR THE GOOD OF THE PEOPLE: 1984  
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### CONTENTS

Introduction.....	1
The Federal Ministry of Science and Technology.....	2
Basic Orientation of Research and Technology Policy.....	4
Federal Research Report 1984.....	4
Indirect Types of Support.....	6
Minimizing Red Tape.....	6
Future Development of Research Institutions.....	6
Basic Research and Long-Term Basic Research Programs.....	8
The Max Planck Society for the Support of the Sciences.....	9
Large Installations for Basic Research in the Natural Sciences..	9
Oceanology.....	10
Polar Research.....	10
Space Research and Space Technology.....	10
Earth Sciences.....	14
Humanities and Social Sciences.....	15
Support for Research and Development in the Acquisition of Preliminary Knowledge for Present-Day Readiness and Future Preparedness.....	17
Ecological Research.....	17
Environmental Research and Technology.....	18
Hydrology.....	19
Climatology.....	20

Safety Research and Safety Technology.....	21
R&D in the Service of Public Health.....	21
Humanizing the Workplace.....	22
Ground Transportation and Traffic.....	22
Raw Materials Research.....	23
Construction Research and Technologies:	
Rational Energy Use in the Construction Sector.....	23
Energy Research and Energy Technology.....	24
Technology Assessment.....	29
Support for Research and Development in Key Technologies.....	31
Information Technology.....	31
Manufacturing Technologies.....	33
Biotechnology.....	33
Materials Research.....	35
Technologies Related to Physics.....	36
Chemical Engineering.....	36
Aeronautical Research and Technology.....	37
Oceanology.....	37
Improving the Framework for Research, Development and Innovation in the Private Sector.....	39
Fraunhofer Society for Applied Research.....	39
Transfer of Technology and Know-How.....	40
Research Cooperation Between Industry and Science.....	40
Joint Research.....	41
Sponsorship of the Hiring of Additional Research Personnel.....	41
Start-Up of New Technology-Oriented Companies; Venture Capital..	42
Specialized Information.....	42
German Research Network.....	43
Other General Types of Sponsorship of Research and Technology.....	44
Collaboration With the Federal States.....	44
International Cooperation.....	44
Fellowships for the Exchanges of Scientists.....	48
Public Relations and the Dissemination of Additional Information Concerning Research, Technology and Innovation.....	49
Supplement: Timetable of Important Events.....	52
Appendix: Organization of the Federal Ministry of Research and Technology.....	55

[Introduction] In the *Federal Research Report for 1984*, the Federal Government describes the guiding principles of its research and technology policy as well as the resources that exist in the FRG in the areas of science, research and development. An abbreviated version (132 pages) of this seventh Federal Research Report can be obtained from the Referat Öffentlichkeitsarbeit, Bundesministerium für Forschung und Technologie, Postfach 200706, 5300 Bonn 2. The full-length version (429 pages) can be purchased in bookstores at a cost of DM 15.00. The complete version contains a survey of research activities and facilities that are supported by the Federal and State governments as well as an overview comparing the international cooperation and support for scientific investigation carried out by the FRG as compared with other countries.

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## **The Federal Ministry of Science and Technology**

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The Federal Ministry of Science and Technology (BMFT) supports basic research, applied research, technological development and innovation measures; it coordinates all measures undertaken by the Federal Government in this area.

### **Management and Organization**

The Ministry is headed by Federal Minister Dr. Heinz Riesenhuber (CDU); Dr. Albert Probst (CSU) serves as parliamentary state secretary and Hans-Hilger Haunschild as state secretary. It is divided into five departments:

- administration; basic questions concerning research and technology policy;
- basic research; coordination of research; international cooperation;
- energy, security;
- information and production technology; living and working conditions, technical information;
- aeronautics and space technology; raw materials; earth sciences; transportation.

### **Staffing**

At the end of 1984, the Ministry (excluding auxiliary units and institutions carrying out projects) employed 578 workers, 227 of whom are active at the administrative level.

### **Budget**

The Ministry's 1984 budget, which was prepared in 1984 and which was increased by 2 percent to DM 7,049 billion, clearly reflects the new orientation of research and technology policy that was introduced in 1982/83, above all with a continued increase in expenditures for basic research, for key technologies and for an improved framework for research and development (R&D), as well as for innovations in the private sector, while expenditures for energy research in particular have declined.



The BMFT depends upon knowledgeable counsel from all of the various segments of the scientific community and society in order to meet its long-range research and technology policy objectives. Efforts to streamline the advisory function were continued, however, in particular by scrutinizing the functions of the individual advisory committees. The number of committees has been reduced by 13 to a total of 50, and the number of advisors has been reduced by 116 to a present total of 424. Their activities are prepared, supplemented and aided by administrative project steering and project coordination committees as well as by means of colloquia, symposia, public hearings and status seminars. The increase in indirect research support will in the future contribute to further curtailment of this advisory activity.

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# Basic Orientation of Research and Technology Policy

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## Federal Research Report 1984

### Significance

With its Federal Research Report for 1984, the Federal Government has provided both an interim report concerning the new orientation of its research and technology policy and has also compiled a summary of the basic principles and objectives of this policy. The report stresses the vital importance that research and technology have in:

- intellectual and cultural development, i.e. for our knowledge, thinking, and understanding of the world, and in particular for *Orientierungswissen* [knowledge facilitating the acquisition of knowledge], which in political, economic and social terms is becoming an increasingly important prerequisite for the understanding and solving of societal problems;
- scientific and technological innovation as a fundamental prerequisite for a modern, export-oriented national economy;
- increased opportunities for living a humane life (health care, living conditions, working conditions, employment opportunities);
- growth that conserves resources and is not detrimental to the environment;
- the role of the Federal Republic of Germany as a partner in the world.

### Basic Principles

In its research and technology policy, the Federal Government emphasizes the following principles and approaches:

1. affirmation of the freedom of research; stimulation of private initiative and improvement of the conditional framework for science and research;
2. basic affirmation of technological change as a basis for growth and employment and for the solution of urgent and increasing problems resulting in part from an overly careless use of technology;
3. the recognition of achievement and incentives for top achievements in research, development and innovation;



4. allocation of public funds as subsidies to the private sector, i.e. only in those areas which fall under the responsibility of the state and where, for predominantly societal reasons or reasons concerning the economy as a whole, independent research and development in the private sector require outside support;
5. cooperation between the scientific and business communities and the government, without obfuscation of responsibilities; effective coordination between the federal and state governments and between the federal administrative units;
6. strengthening the institutions of science and scientific support, e.g. the *Deutsche Forschungsgemeinschaft* [German Research Association = DFG], the *Max-Planck-Gesellschaft* [Max Planck Society], the *Fraunhofer-Gesellschaft* [Fraunhofer Society] and the large research facilities, which are in a process of reorientation towards new objectives, including the reduction of unnecessary bureaucracy;
7. helping to ensure the availability of qualified future generations of scientists;
8. stricter quality standards in the awarding of grants; consolidation of R&D capacities particularly by means of joint research;
9. strengthening of international scientific and technological cooperation.

### **New Points of Emphasis and Objectives**

Problem formulation, methodology and the regulatory integration of research and technology policy are determined by important new points of emphasis. The general objectives, on the other hand, are still valid and find a broad consensus among the political parties; they are also shared by the federal states. The R&D policy of the Federal Government has the following objectives:

- to expand and deepen scientific knowledge;
- to contribute to the preservation of resources and the environment as well as to the creation of humane living and working conditions, and
- to increase economic performance and competitiveness.

### **The Consequences of Technology**

The emphasis on freedom and private initiative in research, development and innovation also requires the clarification of responsibility and the elucidation of and ability to control the consequences of technology.

With regard to questions concerning science and ethics and the individual responsibility of scientists, the Federal Research Report for 1984 determined that

- research must be protected from undue fears, restrictions and attribution of responsibilities;
- it is the responsibility of the state to set in motion the clarification processes necessary for the determination of obligations and limitations.

The most important practical example at the present time is the intensive debate concerning questions of genetic engineering.

## **Indirect Types of Support**

### **Increasing Funds**

In order to improve the research climate and to strengthen the role of the private sector in research and development, the BMFT has considerably increased its indirect and indirect-specific funding for 1984. Compared with 1983 figures, funding for 1984 has increased by 35 percent. In 1985, this type of funding will continue to increase as a percentage of overall BMFT business subsidies. New measures for indirect and indirect-specific support were initiated or decided upon in 1984.

### **Concentration of Direct Project Subsidies**

Together with measures which have already been introduced by the Federal Government (such as special R&D deductions and indirect-specific subsidies in the area of manufacturing technology), funding for indirect measures in 1985 will amount to approximately DM 1.5 billion. The BMFT will continue the restructuring that is already underway and will continue to concentrate direct project support in long-term, complex and high-risk R&D projects.

### **Minimizing Red Tape**

The BMFT views as one of its important tasks that of keeping, within its scope of competence, administrative red tape to an absolute minimum, thereby freeing research subsidies as much as possible from bureaucratic impediments and thus increasing their effectiveness and improving the general research climate. In 1984, progress was made especially in the area of research institutions: joint efforts on the part of the administrative and executive branches resulted in the improvement of their operational sphere in terms of personnel and financial concerns, e.g. by means of expanded mutual matching capability between and within the operational and investment budgets or by means of a pilot program, which as of now involves seven research institutions, that allows for deviations from staffing schedules that are neutral in budgetary terms. However, the reduction of red tape remains a constant challenge for all parties involved in the research process.

## **Future Development of Research Institutions**

### **Government Report**

With its report "Status and Perspectives of the Large Research Facilities," in April 1984 the Federal Government presented a concept for the future of the large research institutions (which are financed by the Federal Government and by those states in whose territories these facilities are located at a ratio of 90 : 10). In this report, the government acknowledges large-scale research to be a cornerstone of research and technology policy. The independent role of large-scale research is to be found in long-term, complex research and

development tasks which require considerable expenditures in terms of financing, planning and management. Large-scale research is essentially complimentary to the other private and state research facilities in the Federal Republic of Germany.

The 13 large research facilities employ at present a total of 20,400 people, including 5,000 scientists. Six of these facilities deal primarily with technologically-oriented questions, including such areas as energy technology, biotechnology, maritime technology and aeronautics; two of them focus their efforts on the area of life and future preparedness with contributions to cancer research and the study of the effects of toxic substances; five carry out basic research with large scientific installations.

### **New Tasks**

Because of the completion of large-scale technological projects, particularly in the area of nuclear energy technology, several large research facilities are currently in a phase of reorientation in terms of the focus of their concerns. New subject matters, such as

- microelectronics, information and communications technology,
- materials research (utilizing experience acquired in nuclear technology and in aerospace research),
- discoveries relating to the causes and effects of environmental pollution

must be taken up. For this reason, the large research facilities are asked to terminate those research and development projects which are ready to be made available to users or which are no longer current.

### **Orientation to the User**

The large research facilities are accepting this challenge. In the implementation of new R&D focal points and in the construction of new large-scale equipment for basic research, they are increasing their orientation to the needs of users in the areas of the economy, science, and the government. They are increasing their contributions to government programs. In accordance with their area of concentration, they are devoting themselves increasingly to:

- joint research;
- technology transfer, also by means of personnel exchange with the business sector;
- help for the start—up of new, technology—oriented companies;
- offering supporting services as well as contract research and development.

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## **Basic Research and Long-Term Basic Research Programs**

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Germany is a country in which basic research has traditionally been accorded a high degree of respect and which has attained a high performance level in its research efforts. Maintaining and raising this performance level are central challenges for research and technology policy.

### **Objectives**

Two objectives are important for basic research:

- the acquisition of deeper knowledge of the world and of human beings;
- the creation of the preconditions for the development of new technologies and industrial products.

Basic research has its place above all in the universities and in the non-academic research facilities which are supported by the government. In 1984, the BMFT increased its expenditures for the sponsorship of basic research to 30 percent of its budget. In addition to continued support especially in the institutional area, improvements of the conditional framework for the sciences are underway and the possibilities for the support of the future generation of scientists are being increased. The support of basic research includes not only the natural sciences: the role played by the humanities and the social sciences has grown as well.

In 1984, the Ministry, together with the states, was successful in further increasing support for basic research at the Max Planck Society, the German Research Association (DFG) and institutes on the "blue list." The BMFT increased its project support at the universities by 12 percent: in 1984, the universities received a total of DM 350 million in grants for approximately 1,800 projects in 16 different fields.

### **High-Level Research**

Increased support for maintaining top achievement levels is another important precondition for the maintenance of and rise in the level of achievement not only in basic research but in applied research as well. For this reason, the BMFT took up several initiatives in 1984 which are to go into effect in 1985. The most important of these initiatives is the joint federal/state program for the support of selected researchers and research groups, which provides for the application of funds under extremely flexible and generous conditions and which is intended to improve the working possibilities for top level scientists and at the same time to recognize and focus attention on their accomplishments. Ten researchers or

research groups are to receive up to DM 3 million, distributed over five years. The DFG is to administer the program.

## **The Max Planck Society for the Support of the Sciences**

The Max Planck Society (MPG) maintains a total of 60 research facilities in various locales, in which approximately 10,000 people are employed, approximately 4,000 of whom are scientists. The 1984 budget amounted to approximately DM 986 million, including DM 923 million from federal and state sources. The MPG primarily carries out basic research in the natural sciences and the humanities. Areas of emphasis include biological research as it relates to the fields of medicine, physical and chemical research and comparative law. Young scientists receive support in comprehensive programs; these programs were expanded in 1984.

### **New MPI**

In 1984 the Max Planck Institute for Social Research, which is to be headed by Frau Professor Maynz, was founded in Cologne.

A department of open-heart surgery is being installed at the Kerckhoff Clinic in Bad Nauheim.

At the Max Planck Institute for Biochemistry and Psychiatry in Munich, three new project groups were established. Financed by the BMFT, they are intended to effect a close coordination between basic biological research and applications-oriented genetic engineering.

At the Max Planck Institute for Meteorology in Hamburg, linear statistical weather forecasting models (so-called regression models) have been developed which are able to forecast the weather for most of Europe during the spring and winter months.

### **Nobel Prize**

Dr. Georges Koehler, newly appointed director of the Freiburg Max Planck Institute for Immunology, received one of the Nobel prizes awarded for medicine in 1984; Dr. Koehler's research concerns the manufacturing of monoclonal antibodies by means of cell hybridization.

## **Large Installations for Basic Research in the Natural Sciences**

### **HERA**

In 1984, construction of the HERA particle accelerator was decided upon and begun at a large installation for the purposes of elementary particle research at DESY in Hamburg at a cost of DM 1.3 billion. It is hoped that this facility will provide new information concerning the origin and composition of matter. Plans are underway for the construction of other large installations



## **Oceanology**

Key developments in the field of oceanology were the construction of a research ship, the METEOR II (total costs: DM 99 million), the beginning of work by the ad-hoc committee "Oceanology Hamburg" with the goal of improving the structure of oceanology in the North German region, as well as the initiating of two joint projects on the circulation and localizing of toxic substances flowing into the Baltic and North Seas. Furthermore, individual projects involving bilateral cooperation between the FRG and Israel, the USA, France, Greenland, Japan and India, among other countries, were sponsored and initiated.

### **METEOR**

Preparations for the construction of a replacement for the research ship METEOR date back to 1978. Construction of the ship is expected to be completed by 1986. This project will mean the realization of ten developments which are the outcome of the BMFT project "Ship of the Future," and will utilize new technology. The ship will be used world-wide for modern oceanographic research and in particular for furthering scientific cooperation with other nations.

## **Polar Research**

### **Polar Aircraft**

In the area of polar research, the Dornier polar airplanes DO 128-6 and DO 228-100, which were developed with BMFT support, successfully carried out their first assignments in the Antarctic; this included German airplanes reaching the South Pole for the first time at the end of 1984.

### **POLARSTERN**

The Organization of the German Shipbuilding Industry acclaimed the construction of the polar research and supply ship, the POLARSTERN. The ship serves the scientific exploration of the Arctic Ocean and the Antarctic Weddel Sea. Engineering studies, in which shipbuilding research, maritime safety agencies and industry took part, led to the Greenland Sea. The results of these studies will be applied directly to the further development of specialized shipbuilding.

## **Space Research and SpaceTechnology**

### **Objectives**

A survey of German space policy by means of studies, advisory committees and extensive political discussions have led to recognition of the following principles as essential components of a future, long-term European and international space policy:



- implementation of a space program which is geared in its main elements, and if necessary, towards autonomy, to strengthen the political and economic independence of Europe;
- securing our space exploration interests in the European alliance by expanding the national industrial potential, economic and research structures and service-support functions, in state-operated research facilities as well;
- inclusion of a broad user spectrum consisting of the entire public sector, the private sector and science and engineering,

in particular by

- continuation of the previous successful use of unmanned systems for space exploration, earth observations and environmental surveillance, research under conditions of microgravity as well as telecommunications;
- further development of the European rocket launcher ARIANE into a more efficient system able to meet long-term needs;
- long-range cooperation between Europe and the USA with regard to the development of a manned space station, while preserving independent European interests.

## **ARIANE/HM-60, COLUMBUS**

As a foundation for the further development of ARIANE, the development of a new, efficient main engine HM-60 is planned, which will lead to a new generation of European launch rockets. For this trans-Atlantic cooperation, German and Italian members of the European Space Agency (ESA) suggested the COLUMBUS concept, which is based on experiences with SPACELAB and which includes both laboratory and living modules, including a supply module as well as free-flying, automatic but serviceable experiment pallets. Both of these projects are important not only because of their scientific, technological and economic significance for research and industry, but also in terms of German-French relations, European integration and trans-Atlantic technological cooperation. In view of the considerable technological and financial commitment involved, the project will be carried out in stages. At present the preparatory phases for Columbus and HM60 are beginning.

## **Space Laboratory**

### **SPACELAB D1 Mission**

After the conclusion of the developmental phase of SPACELAB and its successful test flight at the end of 1983, preparations have been stepped up for the first German mission, D1. This Spacelab flight for experimental programs in the area of materials and life sciences research is planned for Fall 1985.

## **EURECA**

In continuation of the Spacelab program and of SPAS, the first reusable space platform of a German firm, the ESA has begun development of the first European space platform, EURECA, which is to be launched in 1988 and to be recovered by the Space Shuttle after six months in orbit and returned to Earth. With this program Europe is undertaking the first steps in the preparation of space platforms which will be part of the total system of a future space station.

## **Launch Rockets and Applications Satellites**

### **ARIANE 3, ECS 2, MARECS B2**

With the further development of ARIANE 1 to ARIANE 3, double launches of satellites were carried out in August and November 1984, which means considerable savings as compared with the costs of launching individual satellites. In this way, the European communications satellite ECS 2 and the maritime satellite MARECS B2 were launched into their orbits.

### **TV-SAT**

At present, two ECS satellites for postal affairs are available to the European communication agencies that are joined together in EUTELSAT. MARECS B2 was leased by the International Maritime Satellite Organization (INMARSAT) in order to guarantee reliable radio communications between ships and land-based stations. The joint development with France of radio satellites was continued, and the German satellite TV-SAT is to be launched in 1986. With this type of development in satellite technology, European users are now able to meet their needs by using modern European systems as well. This has been true since the successful testing of Ariane, even including the rocket launching.

## **Earth Observation Missions**

The development of the first European microwave satellite for earth observations, the ERS 1, was begun under the leadership of a German company. Work programs were prepared by a user committee for oceanography, meteorology, climatology, geophysics, geodesy, geology, agriculture and forestry sciences.

Furthermore, the development and testing of selected sensors (camera systems, optical electronic scanners, microwave sensor systems, atmospheric probes) as well as the establishment and expansion of a national remote observations data center at the German Laboratory for Aeronautics and Astronautics (DFVLR) were continued.

## Space Sciences

### **AMPTE, ROSAT**

In August 1984, three AMPTE satellites were launched under German-American-British cooperation. They are used for space research in magnetic sphere physics and space plasma physics, also using artificially created plasma clouds for this purpose. One of the satellites was built in the FRG. After functioning efficiently for ten years in space, the solar probe Helios made it possible to measure an entire solar cycle. The satellite project ROSAT, begun in 1984 for the first comprehensive charting of x-ray stars which only can be observed outside of Earth's atmosphere, is being carried out jointly with the USA and Great Britain. These projects are of an extremely high quality, measured against international standards as well. They are the result of a consistent policy by the Federal Government to support research in the area of space sciences.

## Research and Industrial Capacities

### **Highly Skilled Occupations**

In basic research (university institutes, Max Planck Society), in applied research and in the service area (German Research and Testing Laboratory for Aeronautics and Astronautics) there are at present c. 1,700 skilled workers, and the space industry employs another 4,500 skilled workers. These capacities are an important pre-requisite for the solution of critically important future scientific and technological tasks.

## **Nuclear Fusion Research**

### **EURATOM**

Extensive research at the Max Planck Institute for Plasma Physics (IPP) in Garching near Munich, the nuclear research facility (KFA) in Juelich and the nuclear research center in Karlsruhe (KfK) are devoted to the study of nuclear fusion as a possible source of energy for the future. These research facilities are linked to the European Fusion Program.

### **Tokamak, JET, NET, TEXTOR, ASDEX**

The development of fusion research in Europe as a whole as well as in Germany focuses on the Tokamak series. After the Joint European Torus (JET), which became operational in 1983, an additional Torus facility (Next European Torus or NET) is planned for about 1996, followed after the year 2010 by the first demonstration reactor. The individual national laboratories are cooperating to reach this goal. For example, the TEXTOR (KFA) experiment is testing the interaction between hot plasma and various materials of the first wall. The ASDEX experiment studies the possibility of cleansing the plasma from the nuclear fusion residues (helium) by a so-called divertor. This investigation demonstrated

the existence of a thermal insulation layer at the edge of the plasma (h-regime), which promises a reduction in the thermal stress of the first wall. At present IPP is planning and building an even larger tokamak machine with a divertor (ASDEX upgrade) which is to be used to study reactor-relevant energy flows.

### **Stellarator, Wendelstein**

The Stellarator series as the most attractive alternative to the Tokamak is being further developed only in the FRG in consultation with Germany's European partners. Experiments carried out at the Stellarator Wendelstein W VII A succeeded in creating a cytoplasmic inclusion. This makes it possible to operate the Stellarators, in contrast to Tokamak, in a stationary way, without cyclical, pulsating stress. At present the Stellarator at the IPP is being further updated by means of modifications to become Wendelstein VII AS. This is to demonstrate a modular coil construction and to create a Stellarator plasma for the duration of a few seconds.

### **Development Cooperation**

IPP and KFA are working together in development cooperation to study the technical problems of a fusion reactor, in order to keep up with current developments in plasma physics as it relates to nuclear fusion.

### **Earth Sciences**

With its support of two large earth sciences projects, the continental Seismic Drilling Program (KTB) and the German Continental Reflection Seismology Program (DEKORP), the BMFT has made an important contribution to the research activities of the International Lithospheric Program and to the European Geotraverse.

#### **KTB**

Within the framework of the KTB, a seismic bore of 12-14,000 meters is intended to provide information on important questions in lithospheric research:

- What kind of structure does the subsoil of Central Europe have and how did it originate?
- What kind of composition do the rocks at great depths have today and what was their composition in earlier ages?
- How do the rocks act under the temperatures and pressures that prevail at great depths?
- What kind of chemical reactions take place at these depths?
- What kind and quantity of gaseous and volatile substances (fluids) are contained in Earth's crust?

— How do the fluids move in the lithosphere and what influence do they have on processes that take place there?

— What tensions prevail in Earth's crust and how are they relieved?

The preparations of the KTB were continued in 1984 by geological studies of possible drilling sites in the Black Forest and the Upper Palatinate. At the heart of these studies was the implementation of vibro-seismic profiles in the Black Forest. The evaluation of these measurements will be continued in 1985.

## **DEKORP**

DEKORP covers the mountains of central Germany with a network of seismic profiles in order to study the structure of the subsoil of the Mittelgebirge. The first profile which led from the Danube across the Noerdlinger Ries area to the Taunus was concluded in 1984. DEKORP is an essential part of the European Geotraverse, which will illuminate the European continent in a broad profile extending from the North Cape across Germany to Tunisia in Africa.

## **Humanities and Social Sciences**

### **Grant Program, Protection of National Treasures**

With the passage of the BMFT grant program for the humanities at the end of 1983, new accents were placed. In this regard, the Science Council studied and recommended the establishment of a German historical institute in the United States. The BMFT also requested the Science Council to study the question of establishing an institute for the humanities and social sciences in Japan. With regard to the protection of national treasures, a plan for the support of R&D for the preservation of building materials and the care of monuments was worked out.

In supporting existing humanities research facilities in Florence, Rome, Paris and London, the focus of attention lay on the continuation of existing projects. In view of the difficult political situation in Lebanon, the Federal Government is studying ways in which the existence and working possibilities of the Oriental Institute in Beirut can be secured.

### **Program for the Academies**

The Program for the Academies, jointly financed by the Federal and State governments, which includes long-term projects especially in the area of the humanities, was expanded from 75 to 89 projects.

### **Social Sciences**

Support for the social sciences is oriented toward the objectives outlined in the Federal Research Report for 1984, in particular with regard to questions of technological and economic change, the acceptance of technology and technology assessment. New research projects are intended to minimize theoretical deficiencies and to close the gaps in methodical instruments.

### **Peace Research and Conflict Resolution**

The reorganization of peace research and conflict resolution has become effective on the basis of the report of the Science Council of 1983 and has been initiated at the German Research Association.

### **Scientific Research**

The BMFT has also initiated discussions concerning questions of scientific research and the ethical responsibility of scientists.



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## **Support for Research and Development in the Acquisition of Preliminary Knowledge for Present-Day Readiness and Future Preparedness**

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In the areas of the environment, climate, health care and improvement of working conditions, the State is obligated to take precautions against the risks inherent in a vulnerable world. In 1984, the Government focussed its attention on such topics as damage to the forests, toxic waste disposal sites and on the great diseases of civilization: cancer and cardiovascular illness.

The question of compatibility with the environment plays a decisive role not only in the meeting of energy needs. The damage to the forest, which has received much attention, and also serious developments in water and soil management underscore the necessity of obtaining deeper insights into the interrelationship that exists between human activities and nature, by means of ecological research, so that far-reaching and perhaps even irreversible damage can be avoided or at least minimized.

### **Ecological Research**

Ecological research is a focal point of the BMFT program "Environmental Research and Environmental Technology."

### **Stepped-Up Impact Research**

The necessity of intensified and early impact studies as the heart of ecological research first became clear in relation to the problem of forest die-off. In 1984, after a study that had lasted just one year, valuable contributions were made to clarifying the complex of causes, by means of intensive interdisciplinary research support concentrated in selected locales.

In 1983 and 1984, the BMFT approved a total of 75 projects which received grants amounting to over DM 75 million.

### **Research on the Causes of Damage to the Forests**

Initial results of the BMFT sponsorship were presented in October 1984 at the status seminar on "Research on the Causes of Forest Damage" in Goettingen and were made public by the BMFT in November 1984.

At the end of the year, the research advisory council "Forest Damage/Air Pollution" presented a comprehensive evaluation of the knowledge that has been achieved to date on the question of forest damage.

### **Protection of the Soil, Atmospheric Processes, Development of Models**

In the future, in addition to questions of forest damage, ecological research will step up its study of problems related to protection of the soil and water management, the atmospheric processes by which trace elements are transformed and dispersed throughout the atmosphere, the development of methods and models, particularly for strongly anthropogenic ecosystems, as well as the clarification of possible links between environmental pollution and health hazards. In this process, pertinent experience acquired by other countries will be used to deal with domestic environmental problems, by means of a stepped-up international exchange of information — within the EC via research programs and concerted actions — by East and West jointly within the framework of the United Nations Economic Commission for Europe (ECE) as well as in UNESCO's ecological program "Man and the Biosphere," and in contact with Third World countries as well as through bilateral contacts, e.g. with the USA and Sweden.

### **Environmental Research and Technology**

The Federal Cabinet approved the program of environmental research and environmental technology which was presented to it by the BMFT on March 21, 1984. From 1984 to 1988, the program provides for expenditures of DM 691 million for ecological research and the encouragement of technologies aimed at the reduction of environmental pollution and of low-emission technologies and products.

### **Clean Air Measures**

Funding was stepped up in 1984 for technologies and processes which reduce or completely eliminate the emission of toxic pollutants into the air. This includes techniques for the removal of sulphur and nitrogen from industrial emissions and for the reduction of heavy metals and organic toxins.

### **Waste Management**

A second focus of attention concerned the development of processes aimed at the environmentally sound disposal of problematic wastes, e.g. pyrolysis processing, techniques for the chemical destruction of halogenated hydrocarbons and for cleaning up old waste disposal sites.

### **Sewage Treatment**

In the area of sewage, processes were developed for the utilization of the increasing quantities of sludge and contaminated sediments resulting from sewage treatment as well as from the purification of highly contaminated waste water.

## **Keeping the Oceans Clean**

In order to clean up oil spills on the high seas, the "Bottsand," an oil- separating ship, and other specialized vehicles were built.

## **Low-Emission Technologies**

These environmentally-sound technologies include a new process for the manufacturing of chemical wood pulp.

## **Hydrology**

### **Drinking Water**

Efforts to develop new technologies for supplying pure drinking water focus on the removal of nitrates from ground water. This is taking place with a view to the reduction of the maximum permissible level from 90 mg/l to 50 mg/l (EC standard). Financial help was made available for projects dealing with the physical/chemical and biological removal of nitrates in the water treatment plants and the subsoil. In the course of 1984, three pilot and/or demonstration projects were initiated: a facility in Bad Rappenau for an environmentally-friendly process (CARIX) using an ion exchange technique, and facilities in Langenfeld-Monheim and in Moenchengladbach using various types of biological treatments.

The hardness of drinking water is becoming a growing problem; modern technological solutions were tested under laboratory conditions.

Other studies concerned the removal of biological anomalies in reservoirs and the microbial removal of hazardous substances from the ground water. Furthermore, initial projects were begun to inspect the ground water and to establish quality control in the use of subterranean water. In the course of 1984, moreover, a screening program was begun to identify and to fundamentally explain previously unknown or unrecognized impurities in surface waters used to supply drinking water (e.g. the Rhine River).

## **Bilateral Cooperation**

Within the framework of a cooperative bilateral research project with Israel, a research program was continued in the area of water technology, including studies for water recycling, for increasing ground water supplies and water hygiene. This program utilized for the first time the German technology of the use of activated carbon in a pilot facility for the treatment of surface water for use as drinking water.

This bilateral cooperation in the area of water technology makes valuable contributions towards the solution of the problem of an adequate supply of drinking water for the Third World.

## **Desalination of Seawater, GKSS**

In December 1984, a pilot facility in Kuwait for the desalination of seawater using reverse osmosis, an energy-saving membrane process, went into operation. The facility consists of three tracks of various types of modules, which were built and installed by three German industrial companies. The facility has a total capacity of 3,000 m<sup>3</sup> of drinking water per day, which in terms of European consumption would suffice to supply a small city of 15-20,000 inhabitants. Partners in this joint project are the GKSS Research Center in Geesthacht and the Kuwait Institute of Scientific Research.

This project concluded the years-long support of the BMFT for desalination research.

## **Climatology**

### **Focal Points**

Government research grants in the framework of the climatology program have up to now been structured and organized in five focal areas:

- global models (linked models, climate diagnostics) and construction of a climatic data center: Hamburg;
- continental climates: Hannover;
- meso—scale models (regional models): Karlsruhe;
- paleo—climatology (climates throughout geologic time): Mainz;
- radiation and cloud formation: Cologne.

### **Next Steps**

An interim report of October 1984 described, among other things, the following urgent objectives:

- consolidation of the cooperation between the National Climatology Program and international programs with the goal of further coordinating strategies for the study of the CO<sub>2</sub> problem and other issues in climatology;
- consolidation of the climatic data center by means of institutionalizing it (Hamburg).

Within the Federal Government, the BMFT has overall responsibility for the program. Previous projects were funded primarily by the BMFT, with grants amounting to DM 10 million in 1984.

## **Safety Research and Safety Technology**

### **Disaster Relief Services**

During the past year, all over the world there were numerous major natural disasters and industrial accidents. One of the tasks confronting research and development is to raise the safety level in technological areas dealing with accidents and natural disasters.

### **Heavy Gases, Fire Fighting**

This is true especially for the transportation of hazardous materials and for the continually expanding use of liquefied gas. By means of systematic risk analysis, potential problem areas are identified and replaced by improved technological and organizational solutions aimed at increased safety. In general, absolute technological safety is not achievable, but it must be in the interest of every community to protect its citizens as much as possible from technological and natural hazards. New technologies in fire fighting and disaster relief can also make a contribution here.

### **Nuclear Reactor Safety — Quantification of Safety Margins and Risk**

Research concerning the safety of nuclear reactors is a long-term responsibility of the State. Joint efforts on the part of research institutes and industry as well as in international cooperation were intensified. For this reason, research efforts focused on analyses of failure and transient analysis, component safety and quality assurance for the reliable operation of nuclear power plants as well as man-machine communication in complex systems. The results achieved will represent an important milestone on the road to a realistic quantification of the safety margins, so that risks involved in the operation of nuclear power plants can be described more precisely than has been done in the previous conservative evaluation.

### **R&D in the Service of Public Health**

The program "Research and Development in the Service of Public Health 1983-1986," which was approved by the Federal Government in 1983, emphasizes the urgency of intensified preventive health care in addition to the further development of our curative medicine. An important event was the beginning of the German Cardiovascular Prevention Study, ending two years of preparatory planning.

### **Rheumatic Research**

In addition to cardiovascular diseases, combating rheumatic illnesses and cancer represents an urgent task for public health policy. A basis for concentrated planning and funding has been created by bringing together all groups active in rheumatic research and calling upon all organizations and research units to contribute to a status report.



## **Cancer Research**

An additional point was made in cancer research: in addition to funding a multitude of individual projects, a committee for coordination and cooperation in cancer research was created within the framework of the overall program for fighting cancer — also with reference to an earlier grant provided by the German Bundestag after improvements in the coordination of research in this area. It is the task of this committee, to which especially state and private financial contributors belong, to avoid the duplication of research efforts and to bring about the coordination of procedures in cancer research.

## **Humanizing the Workplace**

### **Areas of Concentration**

The reorientation of the program "Humanizing the Workplace," carried out jointly by the BMFT and the Federal Ministry of Labor and Social Affairs, has been continued, in keeping with the report on the planning of further development of March 1983, by having new areas of advancement prepared in agreements reached with the collective bargaining parties. The two announcements concerning the search for possibilities of human engineering in the application of new technologies in production, in the office and on the administrative level are of particular importance. The theses concerning the interaction between innovation and humanizing the workplace, agreed upon by the discussion group "Humanizing the Workplace," are closely connected to this and constitute the cornerstone for methods of mastering technical progress in the world of work that has been laid by the social partners.

The updating of already existing support priorities for the reduction of extremely stressful working conditions in certain industries or fields of activity was introduced with the announcement of the industry-specific project, "Foundry Industry." Final agreement is about to be reached on the objectives "Highway Transportation," "Forging Industry," and "Noise Reduction in Sheet Metal Processing." As an example of the areas for which future support is being prepared, "Working Conditions and Health of Employees," could be named, a project which is to initiate epidemiological studies in order to provide further information on the way in which working conditions contribute to the development of widely spread diseases such as cardiovascular and rheumatic illness and diseases of the digestive tract.

## **Ground Transportation and Traffic**

### **Alternative Fuels**

The testing of methanol fuels was successfully concluded with the experiments with M100. The groundwork for reaching a decision is available with the analysis of the possibilities of introducing alcohol-based fuels. These activities are being continued with the market-oriented pilot project for M100 fuel; the testing of hydrogen technology in road traffic was begun.



### ***H-Bahn*, Operational Control System**

Two important milestones were reached in the automation of local public transportation systems: in May 1984, for the first time in Germany, approval was given for the new automatic modular train system, the *H-Bahn*, for use in Dortmund's public transportation system. In December 1984, after a successful trial period, the PUSH *U-Bahn* automation system of the Hamburg Transit Authority was approved for use in local public transportation. In May a trial period began in Hannover, testing a standardized operational control system for busses and city railways: this system is being readied for use in other cities.

### **Transrapid**

As the magnetic rapid transit experimental station in Emsland was being put into operation, the Transrapid-06 set a new record in August 1984 for electromagnetic passenger monorail's, with a speed of 302 km/h. The experimental station is expected to be completed in 1985/1986 with the construction of the southern loop, so that sustained testing can be carried out.

### **High Speed Train Paris-Cologne**

The first stage of studies concerning a high speed train link between Paris-Brussels-Cologne using wheel-track or high speed magnetic technology was successfully concluded by the trilateral working group (FRG, Belgium, France). These studies will be supplemented by the participation of the Netherlands.

### **Freight Transportation**

A plan was drawn up for the logical optimization of freight transportation networks using modern communications technologies to deal with the flow of data that accompanies the freight. The system will be piloted shortly.

### **Raw Materials Research**

The subsidizing of the terrestrial raw materials research, which has been carried out since 1976 within the framework of the program "Research to ensure the Availability of Raw Materials" will be terminated.

### **Construction Research and Technologies: Rational Energy Use in the Construction Sector**

#### **Focal Points**

In 1984, work was begun in the following focal areas:

- the advancement and expansion of underground lines of small diameter for supply and waste removal systems, e.g. district heating, sewage, cable lines, etc.;

- increased use of computer-assisted planning and construction methods;
- development of energy-saving building materials;
- the encouragement of a holistic attitude which regards a building as representing a unity between construction and energy technologies, taking into consideration the total cost in terms of initial investment and the cost of day-to-day operation during the entire life of the building;
- preservation and care of monuments within the framework of the protection of national treasures and as a measure aimed at compensating for past neglect.

### **Joint Research**

In order to assist both the private sector and the universities in determining appropriate directions for their efforts at innovation, the instrument of joint research has received priority since 1984. Practice-oriented topics — formulated by the construction industry — are accompanied by the universities in a technical way in order to provide direct contact between scholarship and research, so that the theoretical knowledge available in the universities can flow directly into research work.

## **Energy Research and Energy Technology**

### **Market-Oriented Framework**

Energy research and technology policy is intended to contribute to the further development of our energy system and its purposeful adaptation to overall economic conditions. The reliability of resources and an economically sound and environmentally acceptable energy supply are the goals. These are to be implemented in consideration of the market-oriented framework and with a concentration of state support in a few critical areas.

On the basis of the existing energy research program, the BMFT in 1984 revised its subsidy program by setting new priorities and changing its emphasis in individual areas.

### **Ensuring the Availability of Energy**

The availability of energy in sufficient volume and in an appropriate form is an indispensable factor in meeting basic human needs. In view of limited natural energy resources and restricted application possibilities for renewable energy sources, the establishing of an environmentally acceptable energy supply will remain an important task for future generations as well, with research and technology making critically important contributions.

### **Concentration of R&D**

In recent years, many different scientific and technological possibilities for the providing of energy have been explored. Some of these theoretical suggestions did not lead to a technologically satisfactory solution, and many ideas that were technologically feasible did

not prove suitable for broad implementation under market conditions. Nonetheless, many results were obtained which today provide a good overview of available energy technologies with their respective strengths and weaknesses. This will make it possible in the foreseeable future to channel R&D funding into a few selected research areas and a few individual problems for which new or fundamentally improved solutions may be anticipated. The present easing of the energy market makes it possible to pursue the remaining tasks calmly and directly, while maximizing the application of available funding.

## **Rational Energy Use**

In July 1984, the BMFT presented a report summarizing its efforts over the past ten years in support of energy conservation. This report was positive only in a limited sense. The broadly-applied subsidies of the past created a practically complete foundation on which to base the evaluation of possible avenues of approach in this area. In the future, the BMFT will concentrate on supporting a few projects which still carry a high degree of technical and economic risk, such as the further development of the sodium-sulphur battery.

## **Coal and Other Fossil Primary Energy Sources**

Developments in the field of mining and coal technology should help to reduce environmental problems caused by the use of coal, alleviate and rationalize underground work and, by improving its commercial efficiency, expand applications for coal.

## **Environmental Standards**

Support for technological improvements should indicate the emission levels which are technologically and economically feasible especially in the use of coal. After the desulphurization of flue gas became a marketable procedure, researchers are now concentrating on the reduction of nitric oxide emissions from power plants. In 1984 a model facility was commissioned to be built with BMFT funding on the basis of the Walther technique with the simultaneous separation of  $\text{SO}_2$  and  $\text{NO}_x$ .

## **New Processes for Power Plants**

In the future, special attention will be paid to the development of power plant processes which take into consideration the requirements of environmental protection at the source: a pressure-driven fluidized bed or coal gasification with subsequent combination process. In 1984 the planning of installations of this type was begun.

## **Coal Gasification**

The industrial phase of coal gasification was introduced in 1982/1983 with the construction of a demonstration plant.

With regard to coal liquefaction, a decision is being prepared concerning the construction of a facility to demonstrate this large-scale technology.

## **New Energy Sources**

The construction and operation of large facilities such as the 300 kW photovoltaic power plant on the island of Pellworm and the 3 mW wind facility GROWIAN, which resumed operation in 1984 after initial difficulties, provide important experience on which to base future developments.

## **Photovoltaic Studies**

Research is now being concentrated above all in the areas of photovoltaic and photoelectric chemistry. In addition, geothermal resources and solar process heat are to be included in the sponsorship of research on new energy sources.

## **Developing Countries**

Most of the renewable energy sources clearly have a greater potential for applications in other parts of the world, above all in the tropical and semitropical developing countries. The Federal Government believes it has an important responsibility to contribute to the solution of the energy problems of the Third World, especially by means of the development of appropriate energy technologies, thereby at the same time improving the chances for German industry in this future market.

## **The Cycle of Nuclear Fuels**

### **Uranium Supplies**

R&D work in the area of uranium reserves has succeeded in demonstrating that deeper-lying deposits which could not be discovered with the use of previous methods can be detected using remote sensing techniques. Studies aimed at reducing radiation and any negative environmental impact were successfully carried out.

### **Enrichment of Uranium**

The technique of gaseous diffusion to obtain enriched uranium, which was developed jointly with Great Britain and the Netherlands, has become competitive. Of the jointly supported 2,000 tons per year construction program of URENCO, by the end of 1984 about 1,200 tons per year had become operational. Government aid for the development of gaseous diffusion will terminate in 1985.

### **Fuel Elements for Research Reactors**

It was demonstrated within the framework of the program "Reduction of Enrichment in Research Reactors" that most research reactors can be refurbished to use fuels with low-level enriched uranium (less than 20 percent enrichment). Plans were begun to work out ideas for the refitting of the plants. In this way the FRG is making a valuable contribution to the reduction of the production and spread of highly enriched uranium that can be used for military purposes.

## **Disposal of Nuclear Wastes**

### **Reprocessing**

On the basis of previous successful developments in reprocessing technology it was possible in 1984 to completely transfer the technological and financial responsibility for the reprocessing of light water reactor power plants to the appropriate industry.

The only tasks in this area that are still the responsibility of the State include safety research independent of facilities, the supervision of fissionable materials and developments in the breeder fuel cycle.

The realization of the German experimental plant Pamela in Mol, Belgium, was continued with the plant beginning cold operations according to plan. In 1985, hot operations are to begin.

### **Permanent Storage of Nuclear Wastes, GSF**

BMFT funding in the area of nuclear waste disposal continues to support research and development in the area of geological storage. R&D work concerning storage in salt formations was carried out, especially in the former salt mine of Asse, which is operated by the Society for Radiation and Environmental Research (GSF). Radioactive substances (Co-60 sources) have been deposited there for research purposes since December 1983 within the framework of a joint German-American project as a preliminary study for the testing of the long-range storage of highly radioactive by-products.

In the R&D work (for the Konrad mining shaft in Salzgitter the procedure for developing the plan was already in operation) the underground investigation of the Gorleben salt deposits with regard to the site's suitability as a final deposit location for all types of radioactive wastes has been given high priority. After the conclusion and evaluation of the drilling program, the results of which have tended to support the suitability of the salt deposits, the construction of two exploratory shafts was begun in May 1984. The mining exploration of the salt deposits by tunneling and underground drilling will begin after completion of the shafts in 1988. The results of this underground exploration with the related failure studies will provide the basis for the final safety analysis within the framework of the public works planning procedure called for under the terms of nuclear regulatory policy.

### **Advanced Reactors**

#### **SNR/THTR**

After financing was obtained for the two prototype nuclear power plants SNR-300 (breeder reactor) and THTR-300 (high temperature reactor), construction of both plants proceeded rapidly in 1984.



## **Breeder Reactors**

During the course of the construction of the NR-300 in Kalkar on the Lower Rhine, the filling with sodium was begun in 1984, in keeping with the overall plan. The measures for project management which were adopted in 1983 have proven their effectiveness: the cost guidelines which were established in 1983 were observed and final completion of the project, originally targeted for the end of 1985, can be moved ahead to the middle of 1985. On December 4, 1984, a facultative public hearing on the proposed changes in the reactor core took place; the results are expected to be available in early 1985.

## **Cooperation Among European Breeder Reactors**

After brief negotiations which were intensively supported by the Federal Government, on January 10, 1984 the governments of the FRG, Belgium, France, Great Britain and Italy signed an agreement concerning European cooperation on breeder reactors, reserving for the Netherlands the right to join at a later date. This agreement forms the framework for several individual agreements concerning cooperation in research and development as well as in industrial applications, which are being worked out at the present time. The goals of this international cooperation are achieving the greatest possible degree of coordination in the development of breeder reactors, the joint construction and operation of at least one large breeder reactor in the FRG (SNR 2), in France (Super Phenix) and in Great Britain (CDFR), as well as cooperation in closing the nuclear fuel cycle. In preparation for the decision regarding the construction of the SNR 2, members of the energy supply industry which participate in the use of nuclear energy in the Federal Republic decided last fall in favor of jointly bearing the German share of planning costs. A discussion group appointed by the Federal Minister of the Interior declared at the end of 1984 that the safety plan for the SNR 2 which had been presented by its manufacturers and operators was found to meet the requirements needed in order to apply for a permit.

## **Further Development of Breeder Reactor Technology**

Work on the further development of breeder reactor technology was continued according to plan in 1984 in the framework of the German-Belgian-Dutch cooperation, with this program being coordinated with French and Italian research and development facilities. In the future, British R&D facilities will also be included in this collaboration. Several of the important results were:

- In 1984 at the experimental breeder plant KNK II in Karlsruhe a peak burn-up was achieved in the case of one fuel element which corresponds to a value twice as high as that for which the SNR-300 core was designed.
- In a load reversal test under near-operational conditions, in the case of an important component of the SNR-300, a stress 30 times as great as that which can be expected during the life expectancy of the SNR-300 was applied before a small leak occurred.
- An ultrasonic device for viewing in the presence of sodium was made operational, by means of which damage to nuclear components can be made visible on a video screen.



## **High Temperature Reactor**

The THTR-300 has been almost completely assembled. The majority of its cycles have been made operational. After the plant was charged in the fall of 1983, zero-energy reactor physics experiments to confirm the mathematical data were successfully carried out. After approval has been given for the opening of the second part of the plant, which is expected in March 1985, output testing will begin. The power plant is expected to be handed over to its operator in October 1985. The projected financing plan which had been agreed upon in 1983 (DM 3.2 billion in construction costs and DM .8 billion in the principal's own funds) was also observed in 1984.

## **THTR Follow-Up Projects**

As a precondition for the commercial utilization of HT reactors, R&D work for the improvement of HTR technology was sponsored, in particular improvement of the special safety technology used for the HTR including preliminary studies for an HTR control system.

## **Nuclear Process Heat**

Plans call for the continuation of R&D in the area of utilization of nuclear process heat until 1986, especially the development and testing of fuel elements, low-grade enriched uranium and additional silicon carbide coating of fuel particles, final work on controlling tritium in the process gas and a large portion of the experiments on the hydrogenized gasification of lignite on the scale of a pilot program. Furthermore, the experiments on the steam gasification of hard coal with the help of high temperature process heat, which had been carried out on a semi-technical basis, were completed. The evaluation of the results of these experiments is expected to be available at the beginning of 1986.

## **Technology Assessment**

New technologies create new opportunities for the further development of that which has already been achieved. The rapid and well-targeted development and mastery of state-of-the-art technology, while at the same time excluding those consequences of technology which are negative or which are felt to be negative, will help to decide whether the FRG will succeed in maintaining its position of leadership among the industrialized countries. Given the ever closer interaction between technology, nature, the economy and society, the impact of technological progress can no longer be assessed by means of generalized plausibility studies alone.

## **Expansion of Technology Assessment**

The BMFT is expanding its technology assessment (TA) in order to improve the system and the analytical tools needed to evaluate the dangers of already existing negative side effects and to acquire the general background information that is required to facilitate decisions regarding new developments. This is not a matter of superficially increasing the acceptance of technology, but rather of shaping technology in an acceptable way, above all in those areas in which it is decisively supported by the State, and by exercising

responsibility toward society, nature and future generations to ensure the rapid implementation of the opportunities offered by modern state-of-the-art technologies.

No new facilities are required for the intensification of TA activity in the FRG. Rather, appropriate preconditions must be created so that existing capacities and available know-how can be efficiently used to deal with present tasks. Attention focuses in this area on the following four points:

### **Early Detection Network, TA Studies**

Important groundwork has been laid for these efforts. With the GFE, the first steps have been taken in the development of an "early detection network," in which other research institutions are also to be included at a later date. Impact research has been intensified and expanded. TA studies in the narrower sense are increasingly being carried out for individual subsidized programs. At present they include the following issues:

- energy technologies, especially the use of coal;
- methanol for use in road traffic;
- new qualification requirements in connection with microelectronic applications;
- information sciences;
- manufacturing technologies;
- biotechnology;
- the impact of new technologies on the labor market and the jobs situation.

### **International Cooperation**

On the international level, TA cooperation with the EC and the OECD has been stepped up and a formal cooperative agreement has been drawn up with the US Office of Technology Assessment.

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## **Support for Research and Development in Key Technologies**

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In many areas of modern technology there is close cooperation between the universities, state-run research institutes and the private sector. This cooperation is an important prerequisite for industry's adoption of new technologies and for the stimulation of new research tasks. Several key technologies (in materials research, laser technology, aviation and information technologies) in the United States, for example, receive strong impulses from the Department of Defense, which acts as a pilot user in the grand style, but also as a supporter of research in industry and at the universities. This poses a great challenge to the capabilities and flexibility of research in the FRG, if it does not wish to be left behind. The Federal Government has taken decisive steps that will allow the FRG to remain a partner in the world-wide competition that is taking place in the most critical key technologies and thereby to guarantee the availability of jobs in the long run as well.

### **Information Technology**

#### **Sponsorship Plan**

In Spring 1984, the Federal Government adopted and published its previously announced plan concerning government support for the development of microelectronics, information and communication technologies (Government Report: Information Technology). This plan spells out the Government's view of the current status of technological development, of development trends and the related economic and social opportunities and risks.

The measures outlined in this report are interdepartmental and include the areas of microelectronics, information processing and technological communications as elements of a total concept. With regard to technological impact assessment, the international conference "1984 and Beyond" was held in Berlin under the joint sponsorship of the OECD.

### **Microelectronics**

#### **Special Program**

The special program "Microelectronic Applications," which was begun in 1982, was successfully concluded in 1984. Of the over 2,400 projects which were sponsored within the framework of this program, a large number has already led to marketable new products based on microelectronics. The indirect-specific type of support, practiced here for the first time, has thus passed its trial run. This new type of grant made it possible to reach

especially small and mid-sized companies and to help them pass across the innovation threshold, a step necessary in the transition to these new technologies.

## Joint Projects

Joint projects for microelectronics with structures smaller than one micrometer were continued. Arrangements were made for a German-Dutch project for the development of a 4 megabit memory. The focus "Design Technologies for Integrated Circuits" continued to be developed with cooperation from the universities and research centers together with industry.

## Information Processing

The measures which had been announced in the Government Report on Information Technologies concerning computer-assisted design (CAD) for computers and software, new computer structures, knowledge processing and pattern recognition (image and speech processing) have begun according to plan. The objectives and contents of the joint projects were initially worked out in a series of short-term projects in 1984 (definition phase). In several cases, the main phase of some projects could be begun in 1984, while other projects will start at the beginning of 1985. In all of these projects several industrial partners and scientific institutions are working together.

## Technological Communications

The ability to compete successfully in the communications technology market depends to a great extent on mastering the key technologies of microelectronics, optical communications systems and integrated optics, but also on the availability of new networks and supporting services. The *Deutsche Bundespost* [German Postal System] presented its views regarding the expansion of the network infrastructure and of services in the Government Report on Information Technology. In this regard, the BMFT supports R&D projects in the areas of:

- optical communications (including glass fibers, semiconductors, lasers, photo diodes);
- integrated optics ("optical chips," "optical computers");
- high resolution television;
- data communications (German Research Network);
- terminal equipment technology for the development of new products and systems (including flat screens and ISDN devices).

## **Manufacturing Technologies**

### **New Program**

The Government's new program for manufacturing technologies has existed since January 1, 1984. In keeping with the reorientation that has been implemented in research and technology policy, the indirect-specific type of support has been the focus of efforts in the industrial area. Further elements of the program include joint research, technology transfer and technology assessment.

### **Indirect-Specific Support**

The manufacturing technology industry above all showed a broad response to the offer of indirect-specific support, which ranged from the industrial application of computer-assisted systems in construction and manufacturing to the development of industrial robots. By the end of 1984 over 2,000 businesses had applied for assistance. Those which received support are predominantly small and mid-sized companies: approximately 75 percent employ fewer than 500 persons.

This interim report demonstrates again that mid-sized manufacturing companies are very open to innovation. It also shows that the guidelines for development were established correctly.

## **Biotechnology**

Recent developments in the area of biotechnology and especially in genetic engineering open up fascinating prospects, but also give rise to concern about possible abuses. By means of many different types of initiatives, in 1984 numerous approaches were created which enabled R&D in the FRG to play a leading role in worldwide activities in these fields. At the same time, ways and means have been opened up whereby possible dangers for man and his world may be dealt with.

In the support of key technologies, biotechnology continues to hold a central position. In keeping with its significance, but oriented to the still limited research capacity in terms of personnel in the FRG, funding in the BMFT budget for research and technology increased by 7.2 percent in 1984 as compared with 1983 figures, to DM 116.4 million.

### **Genetic Engineering Focus Project**

In this time period a third project oriented towards basic research was set up in Munich for genetic engineering research at the Laboratory for Molecular Biology/Genetic Studies Center, a joint project carried out by the University of Munich and the Max Planck Institute for Biochemistry and Psychiatry with additional participation by industry. The major areas being studied range from micro sequencing, enzyme design and biosynthesis, immunology, tumor research and cancer genes, to the utilization of eucariontic cells for genetic research: the long term goal is the use of genetic engineering for practical medical purposes.



## **New Sponsorship Measures, Alternatives to Animal Experimentation**

In the areas of enzyme and bioprocessing technologies, the announcement of new sponsorship measures pointed the way to new focal areas. The research grant program for alternatives to and supplementary methods for animal experimentation was considerably expanded.

## **Interferon**

With the framework of support for the production and testing of human  $\beta$ -interferon, permission was extended to include the treatment of serious illnesses resulting from an uncontrollable virus, thus making the product of a biotechnological process development accessible for a larger range of medical indications.

## **Reorientation of Large-Scale Research, GBF**

The restructuring of large-scale research in the area of biotechnology with a concentration of resources in the Society for Biotechnological Research (GBF) in Braunschweig was introduced with decisive initial steps: shareholders of the GBF decided upon changing the society's memorandum of association; this measure aims overall at strengthening the scientific self-responsibility of the institution and of the professional competence of its supervisory board by including a "scientific committee" composed of outside scientists, at strengthening the decision-making authority of its scientific management and at clearly establishing responsibilities within the society. In addition, a restructuring process was begun which includes an internal reorganization and the strengthening of individual areas of inquiry. With the installation of a new scientific director on March 1, 1984, and the allocation of additional positions in the GBF, the BMFT together with the state government of Lower Saxony has created an additional favorable climate for the scientific development of the GBF.

## **Questions of Biological Safety**

The Federal Government is particularly concerned with safety precautions in the use of biological material. The BMFT published an initial report on the opportunities and risks inherent in genetic engineering in March 1984. In May 1984 a team representing various ministries and the federal minister of justice began work on questions of ethical and legal problems in the application of methods using cellular biology and genetic engineering on human beings.

## **New Government Program**

A comprehensive program of the Federal Government, "Applied Biology and Biotechnology" for the years 1985-1990, was prepared during the time period covered by this report.

## **Materials Research**

### **Steel Research**

For the special program on steel research, which expires at the end of 1985, no new projects were funded.

### **Corrosion, Friction and Abrasion**

The joint projects in the areas of corrosion, friction and abrasion concentrated on questions having to do with the use of materials and material stressing under very demanding conditions, above all for the construction of equipment and facilities, for energy and off-shore technologies. The working out of technological standards and norms for construction and materials that are corrosion-resistant and free of tribology ensured the rapid dissemination and application of the results that have been achieved.

### **Preparation, Metallurgy**

The development of processes and facilities for the preparation of low-grade and complex ores is being carried out in cooperation with the developing countries, but also serves to make use of secondary raw materials in our own country, such as mining dumps, holding ponds, residues and dusts. New metallurgical processes are based on the utilization of low-grade preliminary substances with attention paid to reducing energy requirements. These processes will help to ensure that the FRG maintains a position of achievement and competitiveness in the international competition for this market which is characterized by strongly distorting factors.

### **New Program: Materials Research**

Preparations for a new program on materials research were concluded, with the following five focal areas being identified:

- structural clay products;
- powder metallurgy;
- special polymers;
- composites;
- metallic high-temperature materials.

The program is to begin at the end of 1985. It will in an especially meaningful way help to build a bridge between effective basic research and its technological and economic utilization. In the coming decades new materials will fundamentally change the face of our industrialized world. The materials, which were selected after comprehensive discussions

with well-known experts as the focal points of this program, will according to the present level of discussion play a decisive role. To a large extent they will make possible the development of new technological products and will thereby contribute to the future economic stability of our county.

## **Technologies Related to Physics**

In the sponsorship area of "Technologies Related to Physics," interest focuses on early recognition and evaluation of new technological approaches based on the results of research in the natural sciences, to lead to a technological and economic decision threshold and, when indicated, to begin disseminating this diffusion along broad lines. The present focal areas are laser technology, surface and microstructure technology, low-temperature and plasma technologies and electronic video technology.

## **Chemical Engineering**

In the field of chemical engineering, two areas are being supported which are especially promising for the future:

### **Catalysis Research**

The focal point of catalysis research originated within the framework of the raw materials program in the project "Coal and Synthetic Gas Chemistry," which terminated in 1985. Catalysts are not only of enormous economic importance for the chemical industry — for example, some 75 percent of all chemicals are manufactured in the presence of catalytic processes, 90 percent of all newly operational large facilities operate using catalytic processes —, but they play an important role in the refining of crude oil and increasingly in environmental protection as well. Catalysis research — which includes the entire spectrum of the new and further development of catalysts including optimal catalyst production, clarifying the reaction mechanisms and the best processing layout for reactor apparatus — is for this reason being carried out with great intensity throughout the world. Priority is given to interdisciplinary joint projects.

### **Membrane Processes**

Membrane processes will certainly belong to the key technologies of the coming decade because of their environmental acceptability and profitability. Important innovations in the area of chemical engineering, biotechnology, environmental sciences and the extraction of crude oil and natural gas depend on the utilization of new or improved membranes and membrane processes, quite apart from medical applications with developments such as the artificial kidney, controlled release and artificial organs. While several classical processes are already available as "ready-made articles," other processes with especially high development potential, such as the separation of gases, pervaporation and liquid membrane technology are still in the research stage. Here the support of joint projects is intended especially to improve cooperation between basic research and the more applications-oriented industrial research.

## **Aeronautical Research and Technology**

### **Program Continuation**

The continuation of the Federal Government's third large-scale program for aeronautical research and technology 1985-1988 was by and large concluded. The planned merging with the second large-scale program, which expired at the end of 1982, was not possible, however, because of the reorientation of program planning of the ministry of defense to a new research and technology plan.

### **Focal Areas of Sponsorship**

The BMFT reduced the average size of grants for related projects, in order to ensure that the aeronautics industry would participate to a large extent. Grants continued to be awarded in the following focal areas:

- air foils for passenger planes;
- efficient new manufacturing methods for civil aviation;
- technologies for general aviation aircraft;
- helicopter technology;
- engine technology;
- avionics.

### **ETW**

Preliminary work on the design of the European Transonic Wind Tunnel (ETW) project was concluded. The partner governments of France, Great Britain and the Netherlands have agreed that the ETW will be built in Cologne-Porz at the large-scale scientific installation of the German Research and Testing Laboratory for Aeronautics and Astronautics (DFVLR). Construction costs are estimated at DM 460 million (1984). Construction is to begin in 1987.

## **Oceanology**

### **Marine Raw Materials**

With the research ship SONNE, occurrences of marine mineral raw materials in the Red Sea, in the eastern Pacific, in the ocean south of Hawaii as well as in the vicinity of the Fiji Islands were investigated, with the participation of industry, the universities and other research institutions. These studies led to increased cooperation with the USA, France, the Sudan, Saudi Arabia, Ecuador and the Pacific island nations.

## **Off-shore Technology**

The large-scale experiments with off-shore components in the area of the research platform "North Sea" were continued. Several developments concerned new processes and devices for underwater technology.

## **Ship of the Future**

Work on the development of the "ship of the future" led to the construction of two prototypes, after components had been tested on two refrigeration ships and had proven their reliability. A new focal point was opened up in subordinate research on ship hydromechanics. Work on new types of sailing vessels was continued according to plan. Efforts by industry and the universities served to further develop the study of ship propulsion systems — in particular with a view to future types of fuels.

In the area of coastal engineering, basic research was devoted to questions of the morphological development in coastal terrain and directly at the German North Sea coastline.



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# **Improving the Framework for Research, Development and Innovation in the Private Sector**

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## **Fraunhofer Society for Applied Research**

The Fraunhofer Society (FhG) carries out applied research and development in the natural sciences and engineering fields. It is currently in a stage of rapid expansion. At the present time it employs 3,400 workers, one-third of whom are scientists. The Society's 31 institutes, located in various areas, have a budget of approximately DM 360 million.

### **Contract Research**

By means of contract research, the FhG hopes to increase performance levels in the German economy and to carry out projects for state purposes. Sixty-three percent of its costs are covered by revenues, with the rest coming from basic public financing that is linked to the degree of success of the research that is carried out. In 1984, revenues from some 800 research contracts from industrial and commercial companies amounted to approximately DM 60 million.

### **ILT**

The FhG's main efforts focus on the areas of microelectronics, production automation, materials, manufacturing and processing technologies and environmental research. In 1984 the Fraunhofer Institute for Laser Technology (ILT) was founded in Aachen.

### **Information Technology**

In the field of information technology, the FhG has attained a position of international leadership in the control of complex technological facilities. Research carried out here with BMFT support has led to a system in which glass fibers have been used for the first time to transmit industrial information. Microcomputers distributed throughout the facility can oversee malfunctions. In the control station, the usual complex display units have been replaced by a color video screen. For the development of this system, FhG scientists received a BMFT technology transfer prize for 1984.

In order to acquire in time the technological know-how needed for the electronic circuits of the 1990's, the FhG is working together with the German semiconductor industry on x-ray lithography, which is intended to replace the manufacturing of chips using light. The FhG team for microstructure technology in Berlin is recognized internationally for its outstanding achievements.

## **Energy Conservation**

In a joint project sponsored by the BMFT, the FhG is working together with industry to develop wall elements that permit sunlight to pass through, but which trap heat. Mounted onto external walls, the plates cause the sun to heat the wall but let off heat only to the interior. Fifty percent and more in heating energy can be saved in this way.

## **Transfer of Technology and Know-How**

The international competitive ability of the German economy depends not only on the quality and scope of R&D activities, but also to an increasing degree on the rapid and effective marketing of new technologies and technical improvements. For this reason, the following measures were adopted to strengthen the innovative ability of small and mid-sized businesses:

### **Innovation and Technology Consulting**

Since 1977 the BMFT has supported 14 pilot projects which offer advisory services to smaller and mid-sized businesses. The objective of facilitating suitable institutional sponsorship of these advisory agencies which will take over this kind of service in the long run has been achieved in a variety of ways. In 1984, four second generation projects were still receiving support. Moreover, advisory offices for employees, employee representatives, communities and developing countries are also being subsidized.

### **Contract R&D**

In February 1984 the measure for the support of businesses which subcontract research and development projects to third parties, which has been in existence since 1978, was considerably expanded. The following improvements were introduced, especially for smaller firms:

- The previous subsidy rate of 30 percent was raised to 40 percent for enterprises with annual sales of up to DM 50 million.
- Included in the requests which received consideration are those which refer to the start-up or planning phase in the development of products or processes.

With an increase of 80 percent in the number of applications received over a comparable time period of the previous year, this program has grown considerably.

## **Research Cooperation Between Industry and Science**

### **Technology Transfer Via Individuals**

Scientists employed in the private sector are to be active for a limited time in research facilities, in order to strengthen the exchange of information and "technology transfer via individuals" between industry and science. These research facilities include the large-scale

research installations, other institutions jointly supported by the Federal and State governments, the Max Planck institutes, the institutes of the Fraunhofer Society, as well as institutes at the universities and the Organization of Industrial Research Groups.

### **Young Scientists in Key Technologies**

The new BMFT measure should help to greatly expand this kind of exchange of personnel. In the area of high technology, new ideas and impulses can be transformed more quickly and more efficiently into industrial innovations. Young scientists employed in industry will acquire new knowledge at the research facilities and will bring their familiarity with practical problems to bear on the world of research. More young scientists of the baby-boom generation will also thereby receive enhanced employment opportunities.

The employment of up to three young scientists in manufacturing industries will be supported for periods of up to three years, as long as they are active in research institutions and are assigned scientific responsibilities which supplement the R&D activities of the business that is being subsidized. The young scientists should work in one of the key technologies, e.g. in electronics, communications and information processing, materials research, composites, manufacturing automation, robotics, sensor technology, physical technologies, biotechnology, new energy technologies or environmental technology.

### **Joint Research**

Joint research is being increasingly used by the BMFT as an instrument for increasing the efficiency of direct project support, particularly in the case of basic R&D projects in the pre-competition stage, by joining together the research capacities of various institutions in order to deal jointly with a group of problems that are related thematically or functionally, by dividing up the work load.

### **Sponsorship of the Hiring of Additional Research Personnel**

#### **Natural Scientists and Technicians**

A joint plan for R&D support (1985-1988) for persons employed in the private sector was developed together with the federal minister of economics to supplement and to extend indirect R&D support that is especially favorable to mid-sized businesses. Assistance in the form of funds to cover personnel-related expenses is being continued and expanded through "grants to cover an increase in the number of research personnel" for manufacturing companies, including software companies, which is financed by BMFT funding. This affords particularly young scientists and technicians an additional chance to work in their professions and at the same time to develop the scientific capacities which will be decisive for international competition in the 1990's.

#### **Hiring of New Personnel**

These "hiring grants" are intended to sponsor above all the labor-intensive mid-sized and small companies which are engaged in research activities and which plan to expand their research staff by hiring new employees between September 1, 1984 and December 31,

1987. The grants cover 60 percent of gross wages and salaries of the newly-hired personnel for 15 months from the date of hiring and is intended to be used by manufacturing companies, including software companies, with up to a maximum of 3,000 employees and DM 300 million in annual sales.

## **Start-Up of New Technology-Oriented Companies; Venture Capital**

In Summer 1983, the Federal Government began a pilot program whereby support would be given to new and young technology-oriented companies by means of a series of suitable instruments of support, using these instruments to gain experience and to stimulate the involvement of private venture capital in such companies. The strong response to this offer of support has led the Federal Government to increase the funding available for the experimental model and to open up other avenues for start-up projects: projects from selected areas in biotechnology as well as projects from 50 start-up centers and technology parks. An additional stimulus for the venture capital companies is provided by the fact that the difficult process of evaluating technology-oriented companies, which must be carried out by outside specialists, can be sponsored for a limited period of time. The strong interest shown by the new venture capital companies and their associated companies since the second half of 1984 is especially welcome.

The risk-sharing contract concluded ten years ago between the Federal Government and the German Venture Financing Company (WFG) has been prematurely ended by mutual agreement. The WFG will continue its operations solely in the private sector and is thus in free competition with the many newly-founded venture capital companies.

## **Specialized Information**

### **Preparing the Program**

Under the leadership of the BMFT, in 1984 a specialized information program 1985-1988 of the Federal Government was designed and agreed upon with members of the various professions. The program aims at improving the framework for the specialized information market, so that private initiatives have a greater opportunity to expand, especially within the area of economic information. It describes the development of data banks in the area of scientific-technical and discipline-specific specialized information, supported in a subsidiary way by the Federal Government, which can be accessed via computer centers for specialized information.

Focal activities of the year 1984 included

- the development of the joint network STN International, which facilitates access for German users to a large number of domestic and foreign data banks and opens up new marketing opportunities for the German supply of specialized information, especially in the USA;
- a joint project for electronic publication, in order to develop and test especially for publishing houses and specialized information computing centers the integrated sequencing of operations for the production, editing, storage and processing of technical and scientific texts;

- preliminary studies for a data bank of chemical documentation at the Beilstein Institute, to be accessed via STN;
- the development of a German patent information system.

## **German Research Network**

### **Computer Network**

Representatives from academic research establishments, large-scale research installations, the MPG, FhG and industry founded the "Society for a German Research Network" with headquarters in Berlin, at the end of March 1984. The organization sees as its primary goal the development and operation of a computer network for research purposes. This project, which is the largest joint project in the area of communications technology, will link computer centers at the universities and at governmental and industrial research facilities with each other by using the public telecommunications network. The purpose of such a computer network is to facilitate the exchange of data, computer programs and news among the various participants. In addition, the network should make it possible to access distant, expensive specialized computers and computer services. This new communications vehicle is expected to be especially useful in the areas of computer-assisted design of microelectronics, machine construction and high-energy physics.



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## **Other General Types of Sponsorship of Research and Technology**

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### **Collaboration with the Federal States**

For the first time, the Federal Report on Research for 1984 also described the contributions of individual states to the research situation in the FRG. In addition to their primary task of supporting university research, the states have developed to varying degrees their own research and technology policies in the interest of regional structures.

The BMFT has greatly intensified cooperation with the states. In a discussion of technology policy with the conference of economic ministers of the states held on February 16, 1984, 14 guidelines were established for the support of technological development and innovation. A discussion of research policy at the Federal and State Commission for Educational Planning and Support of Research together with the jointly supported facilities serves the goal of improving the achievements of German research.

In talks with the individual states, problems of state research and technology policy and the possibilities of support from the Federal Government were dealt with.

### **International Cooperation**

#### **Europe and Western Industrialized Countries**

##### **EC, ESPRIT, Other Long-Range Programs**

A great step forward in EC research policy was the implementation of the exemplary research program "Information Technology (ESPRIT) 1984-1988," which was passed by the Council of Research Ministers with funding amounting to 750 million European Currency Units in February 1984. Moreover, the program "Data Processing" was extended and stepped up, the environmental research program covering issues ranging from impact research to air pollution was considerably intensified and with the resolution concerning the program "Specialized Information Market in Europe" especially the ESPRIT program received a necessary boost. And finally, the council reached agreement on December 19, 1984 concerning the content and funding of a series of long-range programs. These include the follow-up programs "Nuclear Fusion" (1985-1989), "Radiation Protection" (1985-1989), "Management and Storage of Radioactive Wastes" (1985-1989) and "Non-Nuclear Energy" (duration: 4 years) as well as the new programs "Stimulation of Scientific and Technical Cooperation and Exchange in Europe" (duration: 4 years), "Basic Research in the Area of Industrial Technologies" (duration: 4 years) and "Biotechnology" (duration: 5 years.) The passage of these resolutions guaranteed the

continuity of important EC programs and at the same time initiated new actions in those areas where a strengthening of the competitive ability of European industry and the productivity of European research is important and can be expected. At the same time, the first framework program for the scientific and technological activities of the Community proved its usefulness as a planning mechanism.

Within the framework of the nuclear fusion program, the Joint European Torus (JET) was dedicated in Culham, England, in April 1984: this is a large-scale experiment that represents an important step forward in the development of a future demonstration fusion reactor.

### **Council of Europe**

A conference of the research ministers of the Council of Europe on September 17, 1984 in Paris led to recommendations for improving cooperation in the area of research and for the increased mobility of scientists. The way was paved for two large-scale European projects in the course of the year: the European Transonic Wind Tunnel (ETW), which is being built in Cologne-Porz, and the European Synchrotron Radiation Facility (ESRF), which will probably be built in France.

### **ESA**

In 1984, Europe could look back upon 20 years of cooperation in the area of space research, under the framework of the European Space Agency (ESA) and its predecessors, the European Space Research Organization (ESRO) and the European Space Vehicle Launcher Development Organization (ELDO). With the successful conclusion of important programs like SPACELAB and the implementation of the rocket launcher ARIANE for commercial starts, the year 1984 has an important place in terms of new planning for the coming decade. A long-term program was designed, the most important projects of which include COLUMBUS as a European contribution to cooperation with the USA for the development of a space station and the further development of ARIANE. Agreement was reached on the new program at a conference of ministers at the ESA.

### **CERN**

The Center for Nuclear Research (CERN) in Geneva celebrated its 30th anniversary in September 1984. For establishing proof of the carrier of electro-weak interaction, CERN scientists Professor Carlo Rubbia and Dr. Simon van der Meer were honored with the Nobel Prize for physics. A team of 130 physicists participated in the successful experiments, including a research group from the University of Aachen.

### **ESO**

The European Organization for Astronomical Research in the Southern Hemisphere (ESO) with headquarters in Garching has decided to build a large sub-millimeter telescope in Chile in joint cooperation with Sweden.

## **EMBL**

Finland is the 12th country to become a member of the European Laboratory for Molecular Biology (EMBL), located in Heidelberg.

## **Economic Summit Conference**

The working group "Technology, Economic Growth, Employment," which was established at the economic summit conference of heads of states and governments of the Western industrial nations at Versailles in 1982, stressed the need for stepped-up international cooperation in a report it presented to the economic summit conference held in London in 1984.

Summit participants were requested to evaluate the results of the 18 project groups that they had initiated in various important areas of international research and development cooperation for the economic summit conference to be held in Bonn in 1985. The working group also presented a report on the present state of knowledge in important areas of environmental research and outlined a series of recommendations for future research studies, which should be dealt with in particular in the programs of the international organizations (such as OECD, UNEP, ECE, etc.) which are concerned with environmental issues.

## **OECD**

The Federal Government together with the Organization for Economic Cooperation and Development (OECD) sponsored a conference in November 1984 in Berlin on the theme "1984 and Beyond," which offered an opportunity for a general analysis of the possibilities and risks inherent in modern information technologies.

## **Bilateral Cooperation, Western Europe**

The Federal Government supplements its extensive scientific and technological cooperation in the framework of international organizations and research institutions with intensive bilateral contacts and projects undertaken jointly with most of the Western industrial nations. This is especially true of our European neighbors, with cooperation with France playing an especially important role. The traditionally good cooperation that exists especially with Great Britain, Norway, Spain, Greece, the Netherlands, Sweden, Italy, Switzerland and Austria was supplemented in 1984 by efforts to intensify cooperation with Portugal and Ireland.

## **USA, Canada, Australia, Japan**

The especially wide-ranging cooperation with the USA, especially in energy research, space research and technology, medicine and advanced transportation systems, was successfully continued in 1984. The same is true of cooperation with Canada and Australia. At the German Trade Exhibition in Tokyo in 1984, contacts with Japanese science and industry received new impulses by the presentation of examples of German high technology in the areas of energy, transportation, space research and information and production technologies.

## **Global Cooperation**

### **IAEO**

The global character of the International Atomic Energy Organization (IAEO) in Vienna was underscored when the People's Republic of China joined on January 1, 1984, as the 112th member state. Within the framework of this organization, the Federal Government has continued its support for world-wide cooperation in nuclear research and nuclear technology for the peaceful exploitation of nuclear energy and the further development of safety measures.

### **Antarctic Treaty**

The group of consultative states of the Antarctic Treaty continued negotiations in 1984 concerning the regulation of mineral resources in the Antarctic.

### **United Nations**

In order to assist the nations of the Third World in utilizing the possibilities of space technology, in May 1984 the Federal Government together with the UN Space Agency sponsored a conference on accessing and utilizing remote observation data banks, and in July 1984 together with the UN Food and Agriculture Organization (FAO) sponsored a seminar on the uses of remote observations in agricultural areas, which was attended by a large number of experts and high-ranking officials from developing countries.

### **ECE**

Essential impulses for the intensification of international efforts to preserve the purity of the air were generated by the multilateral conference on the environment held in Munich in 1984, to which the Federal Government in cooperation with the UN Economic Commission for Europe (ECE) had invited the signatories to the Geneva Clean Air Convention. The resolutions passed by the conference are of great importance not only in terms of strategies for the reduction of emissions, but also for international cooperation in studying the causes and effects of air pollution.

## **Bilateral Cooperation with the Third World**

The multi-faceted bilateral cooperation with a large number of developing countries which have the necessary scientific and technological infrastructure, above all with Egypt, Argentina, Brazil, China, India, Indonesia, Kuwait, Mexico, Saudi Arabia and Venezuela, moved ahead despite increasing financial difficulties in a number of the partner countries. This is especially true of cooperation with the Latin American countries, with cooperation with Brazil receiving top priority.

## **Indonesia**

In Indonesia, new areas such as coal power plant technology were taken up and the project "Solar Village Indonesia" was successfully concluded.

## **PR China**

The conclusion of a ministerial agreement between the BMFT and the Chinese ministry for space industry concerning cooperation in civilian space research and technology as well as a governmental treaty on cooperation in the peaceful utilization of nuclear energy greatly expanded the scope of cooperation with the PRC in 1984. These agreements also provide important prerequisites for economic cooperation in the planned construction of a Chinese television-radio satellite system, as well as for the realization of the Chinese nuclear power program.

## **Fellowships for the Exchange of Scientists**

The BMFT places great importance on the transfer of knowledge via the exchange of scientists. It sponsors visits by foreign scientists to the FRG.

In 1984, DM 5.3 million were made available for the special US program which combines the awarding of the "Humboldt prizes" to natural scientists, engineers and to medical doctors which are accompanied by invitations to German research institutes. Both this program and a general fellowship program with a budget of DM 1.1 million for sponsoring visits by foreign scientists to German research facilities are administered by the Alexander von Humboldt Foundation.

An additional DM 825,000 were allocated to the German Research Association for the support of scientific relations with the USSR.

The Max Planck Society received the sum of DM 575,000 for cooperation with the Academia Sinica, which it is hoped will enable Chinese and German scientists to carry out joint projects in the PRC.

## **Berlin College of Science**

For visits by top international researchers to the Berlin College of Science, for the first time the BMFT made available in 1984 the sum of DM 2.5 million.



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## **Public Relations and the Dissemination of Additional Information Concerning Research, Technology and Innovation**

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### **Objectives**

The public relations department of the BMFT aims at bringing about an understanding of and confidence in the goals, measures and results of research and technology policy. It also hopes to encourage an orientation to and acceptance of technology by disseminating information concerning the significance of research and technology. In 1984, the importance of research and technology in our lives was demonstrated especially in the focal areas of health care, medical technology, environmental research and environmental technology, climatology and biotechnology.

### **Information for the Media**

In addition to 143 press releases concerning research policy, 78 press reports or "research results" were distributed, containing information on numerous successfully concluded projects. Far-reaching decisions and developments in the area of research policy, such as the Spacelab program, environmental research on forest damage, the Government Report on Information Technology, venture financing, the cancer atlas, polar research and the Europe Transonic Wind Tunnel were introduced to the public at 34 press conferences. In many private conversations and visits to the editorial staffs of newspapers, above all the readiness of the journalists to engage in objective discussions was ascertained. This is a reliable basis for an open and fair collaboration. Contact with the foreign press was intensified in order to bring about the publishing of reports in the foreign press which are appropriate in terms of the achievement level of German science and technology. Foreign journalists now have a special table reserved for them here at the BMFT.

### **Groups of Visitors**

In addition to information for the media, communication with the public was expanded in many areas. For example, approximately 180 groups of visitors, each with an average of 40 persons, visited the BMFT. In short presentations, talks and discussions, often supplemented with the showing of a film, these groups were informed about the tasks of the BMFT and the objectives of research and technology policy by means of selected examples from the projects which are being sponsored. The number of visitors rose by more than 30 percent as compared with the previous year.

## **Publications**

In order to meet the large number of requests for information — every day some 150 written requests are received — in 1984 as well, information papers on the primary focal areas of the BMFT were published. The BMFT Journal, a publication of the Federal Ministry for Research and Technology, appeared a total of 5 times, with 27,000 copies printed of each edition. A Federal Research Report which appears every four years and which was published both in a long and an abbreviated form in May 1984 provides information concerning the research policy of the Federal Government. The *Ratgeber Forschung und Technologie* contains practical tips concerning sponsorship measures in the area of research and technology. The comprehensive compilation of reports, begun 30 years ago for all individual measures of R&D support, was continued with the BMFT Catalogue of Sponsored Projects of 1983. Informational booklets were published in the focal areas of health, the environment, information technology, biotechnology and energy. Information available from the BMFT has been organized and compiled in a List of Publications.

## **Film**

At the beginning of 1984, a survey film "Giving Technology a Direction," based on the work of the BMFT, was completed. This film is designed for use especially with groups of visitors as well as at fairs and exhibitions. After 1985 it will also be available on loan.

## **Public Events**

In March 1984 the Federal Minister of Education and Science and the Federal Minister for Research and Technology called upon German businesses, economic and technological organizations and research institutions to participate in a joint action "Computers and Education." The purpose of this appeal was to assist schools and other educational institutions with concrete help in the education of teachers, in acquiring computer hardware and software and in mastering the pedagogical tasks which are related to the new information technologies. This appeal fell on fertile ground and brought about a number of initiatives. Exemplary contributions from the private sector and from science were presented at a conference held in Bonn on March 19, 1984. A further event took place in Berlin at the end of 1984 with a focus on the opportunities and consequences of the new information technologies: the theme of the conference was "1984 and Beyond." The results of this conference will be published in 1985.

## **Competitions and Prizes**

In order to stimulate research and innovation, in 1984 the Federal Minister for Research and Technology organized a technology transfer competition for the second time. The prizes, each of which carried awards of DM 30,000, for the especially successful transfer of research results to practical applications, were presented in December 1984 by Federal Minister Dr. Heinz Riesenhuber. The competitions "Youth Researches" and "Science Reporters" this year met once again with great interest, which was reflected in the increased number of participants.

## **Exhibitions**

In 1984 the BMFT took part in three exhibitions: the Energy Fair in Sindelfingen, the Hannover Fair and the German Trade Fair in Tokyo. The German Trade Fair met with great interest in Japan. In three weeks over 800,000 people visited this exhibit. The BMFT was represented with a special exhibit on "High Technology from the FRG."

## **Information Offices**

Local information work concerning the disposal of nuclear wastes was successfully carried out in Luechow, Dannenberg District, in cooperation with the State of Lower Saxony. Moreover, the information office in Salzgitter opened its doors to inform the public concerning federal investigative activities in the exploration of the Konrad ore mine.

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## Supplement: Timetable of Important Events

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- January 10      After brief and intensive negotiations carried out by the Federal Government, a governmental agreement on enhanced European cooperation with regard to the fast breeder program was signed in Paris with Belgium, Great Britain, France and Italy.
- February 20     The EC Council of Research Ministers passed a resolution concerning the research program "Information Technology" (ESPRIT).
- February 22     BMFT sponsorship of contract research and development for manufacturing companies was increased and expanded, especially for mid-sized firms.
- March 14        The Federal Cabinet enacted the comprehensive "Plan for the Support of the Development of Microelectronics and for Information and Communication Technologies" which had been announced in the government statement of May 4, 1983 and presented by the BMFT (Government Report: Information Technology).
- March 22        The Federal Cabinet approved of the "Program for Environmental Research and Environmental Technology 1984-1987," which was presented by the BMFT, according to which environmentally relevant R&D projects are to receive funding amounting to a total of DM 2 billion.
- April 9          The European nuclear fusion facility JET was dedicated in Culham, Great Britain.
- April 27        In response to a resolution passed by the German Bundestag on January 26, 1984, the Federal Government presented in the report "Status and Perspectives for Large-Scale Research Facilities" a comprehensive survey and a plan for the future of the 13 large-scale research installations employing a total of 20,400 persons, which are supported by the Federal Government and the states in which they are respectively located, at a ratio of 90:10.
- May 6            The Federal Minister for Research and the Hamburg Senator for Research signed an agreement on the joint financing of the Hadron Electron Ring Facility (HERA), which is to be constructed at the large-scale research installation German Electron Synchrotron (DESY) in Hamburg by 1984, at a cost of DM 1 billion.

- May 21 The joint working group established by the BMJ [Federal Ministry of Justice] and the BMFT to study ethical and legal questions involved in methods of genetic engineering and cellular biology was constituted under the chairmanship of the former president of the Federal Constitutional Court, Prof. Dr. Ernst Bender.
- May 30 The Federal Cabinet approved the "Federal Research Report for 1984," which was presented by the BMFT and which describes the new orientation and perspectives in research and technology policy.
- June 7 The BMFT introduced the comprehensive research project "German Cardiovascular Prevention Study," in which over the coming eight years in various parts of the FRG concentrated preventive programs are to be simultaneously tested for practical health care purposes.
- July 13 The BMFT presented its "Plan for the Support of Rational Energy Use and Renewable Energy Sources," in accordance with which technically mature projects are to be concluded and research is to be concentrated on new, future-oriented undertakings.
- August 14 In an interim report the BMFT explained its activities in supporting and coordinating cancer research in the FRG and reported examples of especially successful results.
- September 17 A conference of research ministers at the Council of Europe in Paris made recommendations for international cooperation among and the mobility of researchers.
- September 26 In response to a joint suggestion by the BMWi [Federal Ministry for Economics] and the BMFT, the Federal Cabinet approved of a "Program to Sponsor Research and Development Personnel in the Private Sector 1985-1988," according to which the BMFT will undertake financial assistance for increasing the number of research personnel in manufacturing companies, including software firms.
- October 15 The BMFT announced a plan and measures introduced for the use of research and technology to protect national treasures and monuments from environmentally-caused damage.
- November 9 Initial results of research on the causes of forest damage were presented by the BMFT in a report on currently funded projects.
- Nov. 28-30 Together with the OECD, the Federal Government sponsored the international conference "1984 and Beyond: The Social Challenge of Information Technology," held at the Reichstag building in Berlin.
- December 4 After receiving approval from the partner governments of France, Great Britain and the Netherlands, the BMFT introduced the large-scale technological project "European Transonic Wind Tunnel" (ETW), a high-level experimental installation for aeronautical research and technology, which is to be built in Porz-Wahn in the State of North-Rhine Westphalia at a cost of DM 460 million.



- December 7      The BMFT is increasing its support for the development of alternatives and supplementary methods to bring about a significant reduction in the number of animals used for experimental purposes.
- December 19     The EC Council of Research Ministers approved a series of long- range R&D programs.

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## **APPENDIX**

# **Organization of the Federal Ministry of Research and Technology**

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**Federal Minister for Research and Technology:**  
**Dr. rer. nat. Heinz Riesenhuber**

**Parliamentary State Secretary:**  
**Dr. agr. Albert Probst**

**State Secretary:**  
**Hans-Hilger Haunschild**

- 1 Administration; Basic Principles of Research and Technology Policy
  - 109 Initial Assessment Office
  - 11 Administration; Finance; Principles of Research and Technology Policy
    - 111 Personnel; Training and Continuing Education
    - 112 Organization; Security; Civil Defense; Continued Development of In-house Communication Techniques
    - 113 Budget
    - 114 Instruments of Advancement for Research and Development in the Private Sector
    - 115 Systems Analysis; Prognosis; Technology Assessment
    - 116 Basic Questions of Research and Technology Policy; Planning
  - 12 Interdisciplinary Questions of Research Sponsorship and Research Installations
    - 121 Principles of the Appropriation Process; Appropriations (Layout Basis); Contracts
    - 122 Appropriations (Cost Basis); Institutional Sponsorship; Project Institutions
    - 123 Law
    - 124 Basic and Interdisciplinary Questions of Research Institutions
    - 125 Personnel Affairs in the Research Institutions
    - 126 Economic Feasibility; Large Projects
  - 13 Infrastructure
    - 131 Language Services; Library
    - 132 Internal Services
    - 133 Internal Data Processing and Documentation; Statistics
- 2 Basic Research; Research Coordination; International Cooperation
  - 21 Basic Research, Research Coordination
    - 211 Basic Research in the Natural Sciences
    - 212 Coordination of Research; Sponsorship of Research in Berlin
    - 213 Administrative Questions of the Research Institutions DESY, GSI, HMI, Foundations
    - 214 MPG, FhG, DFG; Cooperation between Federal Government and States
    - 215 Humanities
    - 216 Social Sciences; Science Research; WZB

Department of Research and Technology with the Commissioner of the Federal Government in Berlin
  - 22 International and Intra-German cooperation
    - 221 Europe; Intra-German Cooperation
    - 222 European Communities
    - 223 International Nuclear Policy; Multilateral Cooperation (IAEO, OECD, Antarctica, Oceanography)

- 224 Multilateral Cooperation, (ESA, CERN, EMBL, ESO)
- 225 Cooperation with America, Africa and Arab Countries
- 226 Cooperation with Asia and Australia
- 227 Technologies for Developing Countries; Matters of International Law and International Personnel

Representation of the Federal Republic of Germany at the European Communities

### 3 Energy; Biology; Ecology

#### 31 Nuclear Energy; Energy Research Program

- 311 Basic Issues and Planning in Energy Research and Energy Technology
- 312 High Temperature Reactors
- 313 Breeder Reactors; New Reactor Systems
- 314 Safety Research and Safety Technology of Nuclear Installations; Juridical Questions Regarding Safety Research
- 315 Cycle of Fuels; Control of Fissionable Materials
- 316 Disposal of Nuclear Wastes
- 317 Research Institutions KfK, KFA, IPP, GSF, GKSS: Scientific and Technical Questions; Fusion
- 318 Research Institutions KfK, KFA, IPP, GSF, GKSS: Administrative Questions

#### 32 Biology; Ecology; Fossil and Renewable Energy Sources

- 321 Basic Issues and Planning in Biological Research and Technology; Gene Centers
- 322 Support for Applied Biological Research and Technology; GBF
- 323 Renewable Energy Sources; Rational Energy Use
- 324 Fossil Energy Sources
- 325 Ecological Research
- 326 Environmental Technology; Safety of Technological Systems

### 4 Information and Production Technologies; Living and Working Conditions; Specialized Information

#### 41 Information and Production Technologies, Support for Innovation

- 411 Basic Issues in Planning; Support for Innovation; Microelectronic Applications
- 412 Technological Communications; HHI
- 413 Information Processing; GMD
- 414 Manufacturing and Processing Technologies
- 415 Electronics; Microprocessor Systems

#### 42 Living and Working Conditions; Specialized Information

- 421 Humanizing the Sphere of Work
- 422 Medical Research and Technology; DKFZ
- 423 Physical and Chemical Technologies
- 424 Specialized Information
- 425 Facilities for Specialized Information, GID: Administrative Questions

### 5 Aerospace; Raw Materials; Earth Sciences; Transportation

#### 51 Aerospace

- 511 Basic Issues and Planning for the Space Program
- 512 New Orbital Systems; Space Shuttle Systems; Utilization of Zero-Gravity
- 513 Extra-Terrestrial Research; Astronomy; Climatology
- 514 Aeronautical Research and Technology
- 515 Administrative Questions of the Research Institutions AWI, DFVLR, IABG, BAH
- 516 Remote Observation; Communications Satellites

#### 52 Materials Research; Earth Sciences; Transportation

- 521 Earth Sciences; Construction Research
- 522 Ground Transportation and Traffic Systems
- 523 Materials Research
- 524 Marine Raw Materials; Offshore Technology
- 525 Oceanology; Polar Research

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